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METHOD OF LAMINATING LIQUID CRYSTAL SUBSTRATES

[Abstract]

PROBLEM TO BE SOLVED: To laminate the upper substrate and lower substrate with high produc tivity, free from mixing bubbles into the gap between the lower substrate and the upper substrate.

SOLUTION: Liquid crystal material 4 is dropped in the space surrounded by an annular seal-line 3 on the lower substrate 1 which is arranged in the vacuum chamber 5 where the upper substrate 2 is laid facing to the lower substrate 1 by means of vacuum-chucking. At least one of the substrates is

moved toward the other substrate and pressurized to laminate keeping the inside of the vacuum chamber 5 in a vacuum-exhaust state. This method has the ability not only to prevent the introduction of air bubbles into the gap but also to vacuum chucking the upper substrate 2 reliably using a short-duration vacuum exhausting means by making the inside of the vacuum chamber 5 under pressure of 50-400 Pa.

[Claim(s)]

[Claim 1] A method for laminating liquid crystal substrates characterized by including the steps of: dropping a liquid crystal material into a space enclosed with a circular seal line on a lower substrate; arranging the lower substrate within a vacuum chamber; vacuum-absorbing an upper substrate within the vacuum chamber for opposing and arranging it to and on the lower substrate; setting a pressure inside the vacuum chamber to 50 to 400 Pa; and moving and pressing at least one substrate toward and against the other one; and joining both substrates.

[Claim 2] A method for laminating liquid crystal substrates characterized by including the steps of: dropping a liquid crystal material into a space enclosed with a circular seal line on a lower substrate; arranging the lower substrate within a vacuum chamber; vacuum-absorbing an upper substrate within the vacuum chamber for opposing and arranging it to and on the lower substrate; vacuum-exhausting the inside of the vacuum chamber for setting its pressure to a predetermined pressure; moving and pressing at least one substrate toward and against the other one so that the upper substrate becomes an inclined state in order to arrange one end of the upper substrate

relative to the seal line at a predetermined gap, when the other end of the upper substrate is contacted with the seal line; and joining both substrates.

[Claim 3] The method according to claim 2 characterized in that the pressure inside the vacuum chamber is set to 50 to 400 Pa to move and press the substrate.

[Claim 4] The method according to claim 2 or 3 characterized in that a gap of 100 to 1000μm is generated between the one end of the upper substrate and the seal line when the other end of the upper substrate is contacted with the seal line, and the both ends of the substrates are then subjected to moving and pressing for regulating a moving speed thereof to be less than 30 to 300μm/sec.

[Claim 5] A method for laminating liquid crystal substrates characterized by including the steps of: forming a circular seal line having a height in a range of $t<T<4t$ on a lower substrate, wherein t is a filling depth of a liquid crystal and T is a height of the seal line; arranging a lower substrate, on which a liquid crystal material is dropped into a space enclosed with a seal line, within a vacuum chamber; vacuum-absorbing a upper substrate within the vacuum chamber for opposing and arranging it to and on the lower substrate; vacuum-exhausting the inside of the vacuum chamber for setting

its pressure to a predetermined pressure; and moving and pressing at least one substrate toward and against the other one; and, joining both substrates.

[Claim 6] The method according to claim 6 characterized in that the pressure inside the vacuum chamber is set to 50 to 400 Pa to move and press the substrate.

[Claim 7] The method according to claim 5 or 6 characterized in that in order to arrange the other end of the upper substrate relative to the seal line at a predetermined gap when the other end of the upper substrate is contacted with the seal line, at least one substrate is moved and pressed toward and against the other substrate so that the upper substrate becomes an inclined state, and both substrates are joined.

[Claim 8] A method for laminating liquid crystal substrates characterized by including the steps of: dropping a liquid crystal material into a space enclosed with a circular seal line on a lower substrate; arranging the lower substrate within a vacuum chamber; vacuum-absorbing an upper substrate within the vacuum chamber for opposing and arranging it to and on the lower substrate; vacuum-exhausting the inside of the vacuum chamber for setting its pressure to a first predetermined pressure; moving at least one substrate toward the other one to allow at least a portion of the upper substrate to be

contacted with or near the seal line of the lower substrate; additional vacuum-exhausting the inside of the vacuum chamber to make the second predetermined pressure less than the first predetermined pressure; pressing both substrates; and joining both substrates.

[Claim 9] The method according to claim 8 characterized in that the first predetermined pressure is set to 50 to 400 Pa and the second predetermined pressure is set to 10 to 50 Pa.

[Claim 10] The method according to claim 8 or 9 characterized in that it includes forming a circular seal line having a height in the range of $t<T<4t$ on a lower substrate, wherein t is a filling depth of a liquid crystal and T is a height of the seal line.

[Claim 11] The method according to any one of claims 8 to 11 characterized in that in order to arrange the other end of the upper substrate relative to the seal line at a predetermined gap when the other end of the upper substrate is contacted with the seal line, at least one of the substrates is moved and pressed toward and against the other substrate so that the upper substrate becomes an inclined state, and both substrates are joined,

[Title of the Invention]

METHOD OF LAMINATING LIQUID CRYSTAL SUBSTRATES

[Detailed Description of the Invention]

[Field of the Invention]

The invention relates to a laminating liquid crystal substratesconstituting a liquid crystal panel in a liquid crystal display apparatus.

[Description of the Prior Art]

In the liquid crystal display device, the liquid panel is constituted of a structure having filling a liquid crystal material into a gap on the order of 5μm between a lower substrate and a upper substrate of translucency material, such as a glass substrate, and the like, via a circular seal line that is consisted of ultraviolet curable adhesives, etc., wherein the gap is held and arranged opposing therebetween and enclosed with the seal line.

In a joining method between the lower substrate and the upper substrate in the state that the liquid material material is filled therebetween, it is disclosed ,for example, in Japan Laid-Open Patent Publication No. 1998-

333157 that a liquid crystal dropping method includes applying adhesives over the upper substrate, forming one or a plurality of circular seal lines, dropping a liquid crystal material into the inside of the space enclosed with the seal line, arranging the upper substrate on it to make an alignment (a position alignment) between the upper substrate and the lower substrate, stacking the upper substrate with the lower substrate to press them until a gap between the upper substrate and the lower substrate becomes a predetermined gap, and irradiating ultraviolet rays to cure the adhesives of the seal line.

As a concrete example for such a method joining liquid crystal substrates, the method disclosed in Japan Laid-Open Patent Publication No. 2000-137253 will be described with reference to Fig. 4. First, as shown in Fig. 4 (a), the method includes applying a sealing material consisted of a ultraviolet curable adhesives on a surface for example, in a circle shape with 30μm in thickness to form a circular seal line 23, mounting and fixing a lower substrate 21 on a position determining table 26 within a vacuum chamber 25 via an elastic spacer 27, with the lower substrate having a space enclosed with the seal line 23 into which is dropped with a liquid crystal material 24, vacuum-absorbing a upper substrate by a absorption table 28 so that the upper substrate is opposed to the top of the lower substrate 21 by opening

the gap thereof, for example, by about 0.5mm, and in this state, regulating a position of the position determining table 26 in a horizontal direction to perform the alignment between the lower substrate 21 and the upper substrate 22.

Subsequently, the method includes vacuum-exhausting the inside of the vacuum chamber 25 so that foams is not doped into the gap, moving down the absorption table by a pressing means 29, for example, in the state under an ambient pressure equal to or less than 100 Pa, to allow the upper substrate 22 to move in a vertical direction, in order to move it toward the lower substrate 21, joining between the upper substrate and the lower substrate by pressing them until the gap g therebetween becomes 5μm, and then, irradiating ultraviolet rays to cure the seal line 23, in order to complete the join therebetween.

Also, the gap g between the lower substrate 21 and the upper substrate 22, which is demanded the precision of submicron, is regulated by a vis between the lower substrate 21 and the upper substrate 22, a post spacer projected on the lower substrate 21, or a fiber filled with the adhesives of the seal line 23, and the elastic spacer 27 is also required to obtain the predetermined gap of the same precision degree, independently of

smoothness of the lower substrate 21, the upper substrate 22, the position determining table 26, and the absorption table 28.

[Problem(s) to be Solved by the Invention]

Accordingly, in order to prevent the doping of foams, since the pressure inside the vacuum chamber 25 is equal to or less than 100 Pa as described above, even though an absorption pressure in the absorption table 28 is about 20 to 30 Pa, their differential pressure does not exceed 80 Pa, and also, since an absorption force of the upper substrate 22 is low, it is apprehended that the very expensive upper substrate 22 or the lower substrate 21 may be damaged by having the upper substrate fallen during work, which has been performed with mechanical processes such as a fine thin film formation, etc.

By contrasting, although the absorption pressure of the absorption table 28 can be considered to be lower further, it is actually impossible to make higher the smoothness of the absorption surface of the absorption table 28 and the upper substrate than current smoothness, in order to fabricate an article on a commercial scale. As a result, in order to lower the pressure, the device will be large and at the same time, it will take time until the predetermined pressure reaches, thereby significantly reducing

productivity. In addition, although an electrostatic absorption can be considered instead of a vacuum absorption, the electrostatic absorption has adversely affect on elements on the substrates or static electricity has a risk to adversely affect on succeeding processes, thereby, it leads to a problem in generalization due to the limitation of an applicable substrates.

As consisting of the invention with considering the problems of a prior art described above, it is an object of the invention to provide a joining method of liquid crystal substrates that is capable of joining a upper substrate and a lower substrate with good productivity, without having a risk that foams will be doped into a gap therebetween.

[Means for Solving the Problem]

A method for laminating liquid crystal substrates of the invention includes dropping a liquid crystal material into a space enclosed with a circular seal line on a lower substrate; arranging the lower substrate within a vacuum chamber; vacuum-absorbing a upper substrate within the vacuum chamber for opposing and arranging it to and on the lower substrate; setting a pressure inside the vacuum chamber to 50 to 400 Pa; and moving and pressing at least one of substrates toward and against the other one, and, joining both substrates, whereby it can prevent foams from doping into the

gap by limiting the pressure inside of the vacuum chamber to 50 to 400 Pa, while even though the absorption pressure of the upper substrate is set to about 20 to 30 Pa so that the smoothness of the upper substrate and the absorption table may be reached a current smoothness at a short time, it can fabricate a good quality of an image displaying liquid crystal substrate with high productivity by absorbing and holding the upper substrate with high reliability.

Furthermore, it includes dropping a liquid crystal material into a space enclosed with a circular seal line on a lower substrate; arranging the lower substrate within a vacuum chamber; vacuum-absorbing a upper substrate within the vacuum chamber for opposing and arranging it to and on the lower; vacuum-exhausting the inside of the vacuum chamber to for setting its pressure to a predetermined pressure; and moving and pressing at least one of substrates toward and against the other one so that the upper substrate becomes an inclined state in order to arrange one end of the upper substrate relative to the seal line at a predetermined gap, when the other end of the upper substrate is contacted with the seal line; and, joining both substrates, whereby due to the contact of the upper substrate with the lower substrate at an inclined state and then pressing removing the inclination, the both substrates can be joined pushing the foams, which has the possibility of

doping into the gap, from one end into the other end so that even though the pressure inside the vacuum chamber becomes high at some degree, it can prevent foams from doping into the gap, thereby fabricating a good quality of an image displaying liquid crystal substrate with high productivity.

At this time, if the pressure inside of the vacuum chamber limits to 50 to 400 Pa to have the substrate moving and pressing, it is preferable to further prevent the foams from doping. Also, a gap of 100 to 1000μm is generated between the one end of the upper substrate and the seal line when the other end of the upper substrate is contacted with the seal line and the both ends of the substrates are then subjected to moving and pressing for regulating a moving speed thereof less than 30 to 300μm/sec, thereby obtaining the effect of preventing the doping of the foams more certainly.

Furthermore, it includes forming a circular seal line having a height in the range of $t<T<4t$ on a lower substrate, wherein t is a filling death of a liquid crystal and T is a height of the seal line; arranging a lower substrate, on which a liquid crystal material is dropped into a space enclosed with a seal line, within a vacuum chamber; vacuum-absorbing a upper substrate within the vacuum chamber for opposing and arranging it to and on the lower substrate; vacuum-exhausting the inside of the vacuum chamber for setting

its pressure to a predetermined pressure; and moving and pressing at least one of substrates toward and against the other one; and, joining both substrates, whereby due to limiting the height dimension of the seal line to a low value, the space volume between the upper substrate and the liquid material can be reduced in state that the upper substrate is contacted with the seal line and upon pressing, the air amount discharged from the seal line is reduced correspondingly so that the air is hardly left and the foams can be prevented from doping into the gap, thereby fabricating a good quality of an image displaying liquid crystal substrate with high productivity.

At this time, if the pressure inside of the vacuum chamber limits to 50 to 400 Pa to have the substrate moving and pressing, it is preferable to further prevent the foams from doping. Also, in order to arrange the other end of the upper relative to the seal line at a predetermined gap when the other end of the upper substrate is contacted with the seal line, if at least one of the substrates is moved and pressed toward and against the other substrate so that the upper substrate becomes an inclined state, and both substrates are joined, it pushes the foams, which has the possibility of doping into the gap, from one end into the other end so that the doping of the foams into the gap can be prevented more further.

Also, it includes dropping a liquid crystal material into a space enclosed with a circular seal line on a lower substrate; arranging the lower substrate within a vacuum chamber; vacuum-absorbing a upper substrate within the vacuum chamber for opposing and arranging it to and on the lower substrate; vacuum-exhausting the inside of the vacuum chamber for setting its pressure to a first predetermined pressure; moving at least one of substrates toward the other one to allow at least a portion of the upper substrate to be contacted with or near the seal line of the lower substrate; vacuum-exhausting the inside of the vacuum chamber more further to make the second predetermined pressure less than the first predetermined pressure; pressing both substrates; and, joining both substrates, whereby the upper substrate, which is absorbed and held in the first predetermined state, moves until contacting with the lower substrate and then pressed in the lower second predetermined pressure state, thereby preventing the foams from doping into the gap more completely so that a good quality of an image displaying liquid crystal substrate can be fabricated with high productivity.

At this time, if the first predetermined pressure is set to 50 to 400 Pa and the second predetermined pressure is set to 10 to 50 Pa, it is preferable to rapidly decompress the upper substrate to the second predetermined pressure state while certainly absorbing and holding, if possible, it in the first

predetermined pressure, since the doping of the foams can be prevented completely. Also, if the circular seal line having a height in the range of $t<T<4t$ is formed on a lower substrate, wherein t is a filling depth of a liquid crystal and T is a height of the seal line, it can preferably prevent the doping of the foams into the gap more further as described above by limiting the height dimension of the seal line to low value. Also, in order to arrange the other end of the upper relative to the seal line at a predetermined gap when the other end of the upper substrate is contacted with the seal line, if at least one of the substrates is moved and pressed toward and against the other substrate so that the upper substrate becomes an inclined state, and both substrates are joined, it pushes the foams, which has the possibility of doping into the gap, from one end into the other end so that the doping of the foams into the gap can be prevented more further.

[Embodiment of the Invention]

An embodiment of a method for laminating liquid crystal substrates of the invention will be now described with reference to Fig. 1 to Fig. 3.

Fig. 1 shows a process of producing a liquid crystal substrate in which a liquid crystal 4 is filled into a space enclosed with a seal line 3, which is formed into a gap g between a lower substrate 1 and an upper substrate 3.

First, as shown in Fig. 1(a), the method includes applying a sealing material consisted of a ultraviolet curable adhesives on a surface of the lower substrate 1 in a circle shape to form a circular seal line 3, dropping the liquid crystal material 4 into the space enclosed with the seal line 3, mounting and fixing the lower substrate 1 on a position determining table 6 within a vacuum chamber 5 via an elastic spacer 7. The position determining table 6 determines a horizontal direction position of the lower substrate.

The sizes of the lower substrate 1 and the upper substrate 2 are 550mm x 670mm. The lower substrate 1 and the upper substrate 2 is formed one or a plurality of an image displaying area (hereinafter, referred to as a display cell) depending of the number of a liquid crystal panels which are fabricated by the lower substrate 1 and the upper substrate 2, so that the circular seal line 3 is applied and formed to enclose the peripheral of the display cell every the display cell.

A filling depth of the liquid crystal material 4 is, for example, 5μm, which is equal to a predetermined gap g every the display cell 4, to control the dropping amount accurately. Also, in state that the liquid crystal material 4 is dropped, its shape exhibits a mountain-type by viscosity as shown in Fig. 1(a). It is required to apply the seal line 3 with the liquid crystal material 4 in

an appropriate height, i.e., the height not to flow for the liquid crystal material 4 over the seal line, upon pressing the upper substrate presses relative to the lower substrate 1. In a prior art, the seal line has a height of about 30μm to be applied with a sufficient margin, but in the present embodiment, the height of the seal line is set to a height as low as possible within a range not to flow for the liquid crystal material 4 over the seal line. More specifically, as shown in Fig. 2, the height of the seal line is set to $t<T<4$, most preferably $2t<T<3T$, wherein t is a filling depth of the liquid crystal material 4 and T is the height of the seal line 3. That is, the height of the seal line 3 is set to 5 to 20μm, most preferably 10 to 15μm, if the filling depth of the liquid crystal material is 5μm

Next, the method vacuum-exhausts the inside of the vacuum chamber 5 using the pressure of 50 to 400 Pa, most preferably about 150 Pa while vacuum-absorbing the upper substrate into absorption table 8 and insertion-arranging it the vacuum chamber 15. The absorption pressure of the absorption table 3 is set to 20 to 30 Pa which is a pressure range to be achieved at a short time, in particular without making a smoothness of the upper substrate or the absorption surface of the absorption table 8 excellent. As a result, the upper substrate can be absorbed and held with high productivity, while due to obtaining a sufficient pressure difference on the order of 100 Pa, which is between 50 and 400 Pa, within the vacuum chamber,

it is not necessary to apprehend a damage caused by falling the upper substrate 2 absorbed and held inadvertently.

Subsequently, a movement pressing means 9, which moves the absorption table 8 up and down and applies a pressure load, allows the upper substrate 2 absorbed and held to be opposed to the top of the lower substrate 1 in the absorption table 8 by opening the gap D, for example, at about o.5 to 1mm. The movement pressing means 9 recognizes as an image position determining marks with which the upper substrate 1 and the lower substrate opposed to each other, respectively, is arranged to adjust the position determining table 6 in order to match them. Four corners of the absorption table 8 are arranged with height regulating members 10 and a position opposed to the height regulating members 10 with which the four corners of the absorption table 8 are arranged is arranged with a up and down direction linear actuators 11, thereby falling the absorption table 8 until each the height regulating member 10 is contacted with the linear actuators 11, as shown in Fig. 1(b). The length dimension of each height regulating member 10 is adjusted and set, so that it allow the one end of the upper substrate 2 to contact the seal line 3 and the other end of the upper substrate 2 to contact each linear actuator 11 at only a predetermined gap d, for example, about 100μm relative to the lower substrate in state that the

inclination of the upper substrate 11 keeps held, as shown in Fig. 3.

Next, the inside of the vacuum chamber 5 is vacuum-exhausted to increase the vacuum degree thereof by elevating the pressure state of the vacuum chamber from P1 of 50 to 400 Pa to P2 of 10 to 50 Pa. Also, all of the linear actuators 11 fall down at a predetermined speed V on the order of 30 to 300μm/sec to remove the inclination of the upper substrate 2 along with the absorption table 8 and move it toward the upper substrate 1. The movement pressing means 9 presses the lower substrate 1 and the upper substrate 2at a predetermined pressure until the gap therebetwee becomes a predetermined gap g. Thereby, the lower substrate 1 and the upper substrate 2 is joined pushing the foams, which has the possibility of doping into the gap, from one end into the other end. After this, the seal line 3 is cured by irradiating the ultraviolet ray to complete the join of the upper substrate 2 with the lower substrate 1.

According to the constitution of the present embodiment, due to limiting a pressure inside the vacuum chamber 5 to 50 to 400 Pa, even though the absorption pressure of the upper substrate 2 is set to about 20 to 30 Pa at a short time, the liquid crystal substrate can be fabricated with high productivity by absorbing and holding the upper substrate 2 with high

reliability.

Furthermore, when the one end of the upper substrate is contacted with the seal line, the other end of the upper substrate moves to be subjected to inclination to have a predetermined gap equal to or greater than 100μm relative to the lower substrate 1 and thus, presses toward the lower substrate 1, whereby due to contacting the upper substrate with the lower substrate at an inclined state and then pressing removing the inclination, both substrates can be joined pushing the foams, which has the possibility of doping into the gap, from one end into the other end so that even though the pressure inside the vacuum chamber 5 becomes high at some degree, it can prevent foams from doping into the gap, thereby producing a good quality of an image displaying liquid crystal substrate with high productivity.

A predetermined gap d is very suitable to have about 100 to 1000μm. Activating the pressure equal to or less than 100μm, an elastic spacer 7, which is between the position determining tables 6 of the lower substrate 1, is elastically deformed so that it is projected from the other end of the lower substrate 1, and thus it cannot obtain the action sufficiently by offsetting inclination amount. By contrasting with this, in the pressure equal to or greater than 1000μm, moving time is needed, effect is reduced relatively, and

productivity is reduced.

Furthermore, due to moving and pressing by regulating the falling speed V from the inclination state to 30 to 300μm/sec using the linear actuator 11, it obtains the effect that the doping of the foams can be prevented certainly. When the number of the display cell on the substrates 1, 2 is small, the falling speed V can set high, because it tends to miss the foams from the space enclosed with the seal line 3. In the mean time, when the number of the display cell is large, the falling speed V can preferably set low, because both substrates 1, 2 is approximately parallel to each other in other end thereof to make the discharge of the foams in each of the spaces enclosed with the seal line 3 difficult.

Moreover, by setting the height T of the seal line 3 to the range of $t<T<4t$ on a lower substrate 1 to limit the height dimension of the seal line to a low value, wherein t is a filling depth of a liquid crystal, the space volume between the upper substrate 2 and the liquid material 4 can be reduced in state that the upper substrate 2 is contacted with the seal line 3 and upon pressing, the air amount discharging from the seal line is reduced correspondingly so that the air is hardly left correspondingly, thereby preventing the doping of he foams into the gap more completely.

The pressure inside the vacuum chamber 5 is set to 50 to 400 Pa and the upper substrate 2 absorbed and held in the absorption table 8 moves toward the lower substrate 1, and after at least a portion of the upper substrate 2 moves to be contacted with or near the seal line 3 of the lower substrate 1, the inside of the vacuum chamber 5 vacuum-exhausts more further to make the pressure within the vacuum chamber into a pressure state of 10 to 50 Pa so that both substrates 1, 2 is pressed and joined, whereby the upper substrate 2, which is certainly absorbed and held in the relatively high pressure state of 50 to 400 Pa, moves until contacting with the lower substrate 1 and then pressed in the pressure state of 10 to 50 Pa, thereby preventing the foams from doping into the gap more completely.

According to the aspect of the present embodiment, a good quality of an image displaying liquid crystal substrate can be fabricated with good productivity.

Also, the upper substrate 2 moves toward the lower substrate 1 for pressing in the present embodiment. By contrasting, it goes without saying that the lower substrate 1 is capable of moving toward the upper substrate 1 for pressing. In addition, even thought the height regulating member 10 and a linear actuator 11 are used as a means for joining at a predetermined speed

after having the upper substrate 2 inclined, the invention is not limited thereto, but can be arbitrarily constituted so that the movement pressing means 9, etc., can have such functions.

Also, in the embodiments described above, even though it vacuum-exhausts the vacuum chamber until 10 to 50 Pa upon performing a pressing process after limiting the pressure inside the vacuum chamber to 50 to 400 Pa, it may be accepted to limit the pressure to 50 to 400 Pa to press and join both substrates 1, 2 using the limited pressure, in order to prevent the doping of the foams. Furthermore, by contrasting, if the vacuum chamber is vacuum-exhausted until 10 to 50 Pa upon performing the pressing process, it is not necessary to limit the pressure inside the vacuum chamber 5 to 50 to 400 Pa, but may accept a pressure higher than that as above. However, if the chamber is vacuum-exhausted in the pressure as above, it can be vacuum-exhausted until 10 to 50 Pa at a short time to enhance productivity.

Furthermore, in view of performing the inclined join of the upper substrate 2 or the height limitation of the seal line 3, they can be performed separately to obtain effects required. However, by suitable combination of each technical means, the doping of the foams can be prevented effectively with good productivity.

[Effect of the Invention],

According to a liquid crystal substrate join method of the invention, it can prevent foams from doping into the gap by limiting the pressure inside of the vacuum chamber to 50 to 400 Pa, while even though the absorption pressure of the upper substrate is set so that the smoothness of the upper substrate and the absorption table may be reached a current smoothness at a short time, it can absorb and hold the upper substrate with high reliability.

Also, by contacting the upper substrate with the lower substrate at an inclined state and then pressing removing the inclination, the both substrates can be joined pushing the foams, which has the possibility of doping into the gap, from one end into the other end so that even though the pressure inside the vacuum chamber becomes high at some degree, it can prevent foams from doping into the gap.

Furthermore, by limiting the height dimension of the seal line to a low value in the range of $t<T<4t$, wherein t is a filling depth of a liquid crystal, the space volume between the upper substrate and the liquid material can be reduced in state that the upper substrate is contacted with the seal line and upon pressing, the air amount discharging from the seal line is reduced so that the air is hardly left, thereby preventing the doping of he foams into the

gap.

In addition, the upper substrate, which is absorbed and held in the relatively high first predetermined state, moves until contacting with the lower substrate and then pressed in the lower second predetermined pressure state, thereby preventing the foams from doping into the gap more certainly.

According to the description above, the invention can practice the methods separately or with combination thereof so that a good quality of an image displaying liquid crystal substrate can be fabricated with high productivity.

[Description of Drawings]

Fig. 1 is a cross section diagram showing a liquid crystal joining process according to one embodiment of the invention.

Fig. 2 is an explanation diagram showing a height dimension of a seal line in the same embodiment.

Fig. 3 is an explanation diagram showing an inclined state of an upper substrate in the same embodiment.

Fig. 4 is a cross section showing a liquid crystal joining process according to an example of a prior art.